Confronting Future Wildfires: A Fire Engineering Approach

Wildfires pose a significant threat to lives and cause extensive social, environmental, and economic damages worldwide. The impacts of climate change have the potential to exacerbate these threats, as we are already witnessing longer fire seasons and more extreme fires in many parts of the world. These extreme fires carry particularly high human costs when they occur in the Wildland-Urban Interface (WUI). As WUI areas continue to grow, the risks of wildfire impacts are predicted to increase.

Our limited understanding of extreme wildfire propagation and its impact on communities has been brought to light by catastrophic fires that have resulted in significant house loss. It is essential that decision-making tools are developed to help land and fire managers predict these fires, but reliable and accurate models are currently lacking. Physical or semi-physical models have limitations in simulating the complex interplay of mechanisms, including dynamic fire effects, fire transition into WUI areas, and smoke exposure, which have been extensively documented. Additionally, the lack of laboratory and field experimental data further exacerbates the problem. In light of these considerations, it is imperative that future research efforts prioritize the following areas in order to address these limitations and advance our understanding of the underlying processes:

1) Conduct comprehensive laboratory and field experiments using state-of-the-art instrumentation to enhance our understanding of extreme wildfires, such as massive spotting, merging fires, pyro-convective events, and their effects on communities;
2) Develop physics-based models to simulate wildfire exposure and community impacts under extreme conditions;
3) Create tools to help land and fire managers in making informed decisions regarding firefighting tactics and ignition strategies for prescribed burns.
4) Connect research findings to assessments of community vulnerability.

Operational implementation of this research within fire agencies will lead to improved fire management and risk prediction through a better appreciation of the full potential of fire behaviour, and an enhanced ability to anticipate dangerous escalations in wildfire development and its impact on communities. This new paradigm in wildfire and fire safety science will underpin the provision of more timely and targeted public warnings about the threat of wildfire, and significant improvements in firefighter safety and understanding of the operational limitations associated with the management of large conflagrations and WUI fires.